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TITLE: FILTRATION EFFICIENCY IN VENTILATED CIGARETTES

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ABSTRACT: Filter ventilation affects cigarette tar delivery by controlling the level of air dilution, the puff count, and the removal efficiency of the filter. Of these factors, filtration efficiency is the least understood. This study describes the performance of a ventilated filter as the combination of two filter segments, one of which is upstream of the vents and the other downstream. According to current filtration theory, the efficiency of the upstream segment should increase with increasing ventilation as the smoke velocity slows and diffusional filtration increases, while the efficiency of the downstream segment should remain constant. Experimental measurements showed that these expectations are approximated in reality, but some important anomalies were observed. The efficiency of the upstream segment increases much more rapidly at high ventilation levels than expected, and the efficiency of the downstream segment exhibits a minimum at intermediate ventilation levels. Even at low ventilation levels, the upstream filter segment is significantly more efficient than the downstream segment. To explain this behavior, measurements of aerosol size distribution, velocity effects, and void fraction filtration were undertaken. The results indicate that the particle size distribution of the smoke aerosol plays an important role in determining the efficiency of ventilated filters and, consequently, the performance of the cigarette.

REVIEW: This paper covered some underlying principles of ventilated filter cigarettes. At the point of ventilation, the filter is considered to be two separate filters with the section at the downstream (mouth) end having gas flow rates which are higher than for the upstream (tobacco) end. As expected based on filtration efficiency theory, the use of ventilation tends to improve overall filter efficiency. This is true primarily because the air drawn in at the side of the filter reduces the gas flow rate in the upstream end of the filter. This lower gas rate upstream allows the smoke particles better diffusion through the filter. Trapping of the particles is enhanced. In the downstream section of the filter the performance is basically unchanged compared with a filter without ventilation. An exception occurs at about the 70% (very high) ventilation level: a slight reduction occurs in filtration efficiency. Particle size distributions were determined for the smoke generated and for the smoke collected. Application of fundamental principles of filtration to the actual particle sizes explains some of the apparent discrepancies. A point of importance to Philip Morris in this area is the difference in performance of the upstream and downstream filter section. Filter design, it appears, should emphasize the upstream filter and minimize the length of the downstream filter.

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